

Free-Surface Modeling of Cryogenic Fluids Using a Higher-Order, Unstructured Grid Volume-of-Fluid (VOF) Method, Phase I

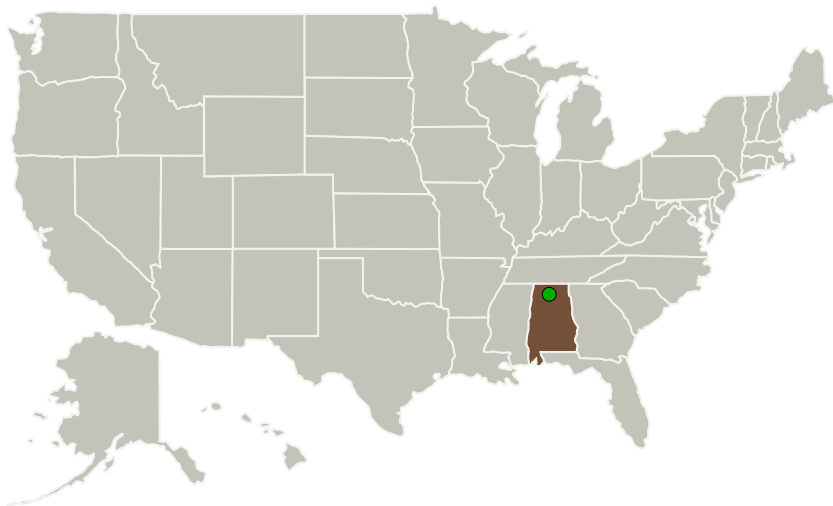
Completed Technology Project (2011 - 2011)



Project Introduction

Accurate and efficient computational modeling of free-surface flows has numerous applications of current and future relevance to NASA. At present, NASA engineers use several commercial codes for modeling cryogenic fluids. However, the free surface modeling technologies in these codes need improvements for better solution accuracy, and most are not scalable for highly parallel simulations. In this SBIR project, CFDRC and Streamline Numerics will develop and implement, in Loci-STREAM, an innovative and improved VOF methodology with the following advanced features: (1) Ability to handle triangle and quadrilateral cell types in 2-D, and tetrahedron and hexahedron cell types in 3-D; (2) Spatially second-order surface reconstruction for these cell-types; (3) Hybrid implicit-explicit time integration scheme that both maintains a sharp interface and allows realistic time-steps for the overall flow solver; and (4) Highly efficient parallelization with scalability to 1000s of processors. To demonstrate feasibility in Phase I, a previously developed 2-D stand-alone VOF module will be coupled to Loci-STREAM and validated. In Phase II, 3-D VOF capability will be developed and integrated with Loci-STREAM. An innovative multi-timescale algorithm that affords significantly larger time steps than standard VOF will also be implemented. Final demonstration of the software will be performed for practical cases to be decided in discussions with NASA/MSFC personnel.

Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
CFD Research Corporation	Lead Organization	Industry	Huntsville, Alabama
● Marshall Space Flight Center (MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations

Alabama

Project Transitions

**February 2011:** Project Start**September 2011:** Closed out

Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/138176>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

CFD Research Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

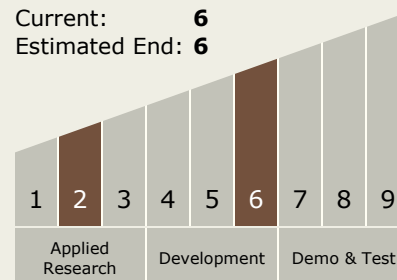
Carlos Torrez

Principal Investigator:

Sarma Rani

Technology Maturity (TRL)

Start: 2
 Current: 6
 Estimated End: 6



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Technology Areas

Primary:

- TX01 Propulsion Systems
 - └ TX01.1 Chemical Space Propulsion
 - └ TX01.1.3 Cryogenic

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System